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FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY 'S DOCKET NUMBER: PTT-133(402582US)

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U S APPLICATION NO (If known, see 37 CFR 1 5): 10/069704

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/08884	08 September 2000	15 September 1999

TITLE OF INVENTION: MEASURING THE PERCEPTUAL QUALITY OF SPEECH SIGNALS INCLUDING ECHO DISTURBANCES

APPLICANT(S) FOR DO/EO/US: BEERENDS, John Gerard

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [x] This is an express request to begin national examination procedures (35 U.S C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [ ] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [ ] Amendments to the claims of the International Aplication under PCT Article 19 (35 U S C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
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   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [x] An oath or declaration of the inventor(s) (35 U.S C. 371(c)(4)). (3 pps.)
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5))

Items 11 to 20 below concern document(s) or information included:

11. [x] An Information Disclosure Statement under 37 CFR 1.97 and 1.98. (with Form PTO/SB08A-B, copy of International Search Report and ten (10) references)
12. [x] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3 31 is included. (2 pps)
13. [x] A FIRST preliminary amendment. (with substitute/clean claims)
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1 825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [x] Other items or information: postcard, Cover Letter (1 pp), Application Data Sheet (1 pps), copy of International Publication No WO 01/20804 with two (2) drawing sheets (FIGs 1-4), copy of PCT Request (7 pps), copy of Notification of International Application Number and International Filing Date (1 pp.), copy of PCT Demand (5 pps), copy of Notification of Receipt of Demand (1 pp), copy of Written Opinion (4 pps), copy of response to written opinion including set of amended claims (9 pps), copy of Notification of Transmittal of the International Preliminary Examination Report with a copy of the International Preliminary Examination Report and four (4) amended sheet s of claims (10 total pps), Submission of Priority Document with certified copy of NL Serial No 1013044 (with English translation)

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U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/069704	PCT/EP00/08884	PTT-133(402582US)

	CALCULATIONS PTO USE ONLY	
21 [x] The following fees are submitted:		
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
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[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$ 00.00	
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(PTT133TRANS/81:ca)

IN THE UNITED STATES
RECEIVING OFFICE (RO/US)

PATENT APPLICATION

Applicant: **BEERENDS, John Gerard**

Case: **PTT-133(402582US)**

International Application No.: **PCT/EP00/08884**

International Filing Date: **08 September 2000**

Priority Date Claimed: **15 September 1999**

Title: **MEASURING THE PERCEPTUAL QUALITY OF SPEECH SIGNALS INCLUDING ECHO DISTURBANCES**

COMMISSIONER FOR PATENTS
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Washington, D. C. 20231

S I R:

PRELIMINARY AMENDMENT

Please amend the above-identified patent application which is simultaneously filed herewith, as follows:

IN THE CLAIMS-

To facilitate entry of the following changes, the Applicant has also submitted herewith substitute pages providing all the pending claims, as they now stand, incorporating the changes indicated below.

Delete claims 1-20 and substitute therefore the following claims:

--21. Method for measuring a talking quality of a telephone link in a telecommunications network, characterized by the following steps:

combining, by means of combining means, a talker speech signal (s(t)) and a signal (r(t)), which occurred in a return channel of the telephone link as a consequence of the transmission of the talker speech signal in a forward channel of the telephone link, to a combined speech signal (s'(t)); and

subjecting the combined speech signal with respect to the talker speech signal to an objective measurement technique for measuring a perceptual quality of speech signals; and

producing an output signal (q(t)) which represents an estimated value concerning the talking quality.

22. Method according to claim 21, characterized in that the combining step comprises a signal addition of the returned signal and the talker speech signal in the electrical domain.

23. Method according to claim 22, characterized in that the signal addition is preceded by an inverse filtering of either the returned signal, or the talker speech signal.

24. Method according to claim 22, characterized in that the returned signal (e4) is taken off from a two-wire part of the telephone link.

25. Method according to claim 22, characterized in that the returned signal (e2, e3) is taken off from a four-wire part of the telephone link.

26. Method according to claim 21, characterized in the combining step comprises a signal combination of the returned signal and the talker speech signal in the acoustical domain.

27. Method according to claim 26, characterized in that the talker speech signal (s) and the returned signal (e5) are combined by means of a microphone, which is additional to the microphone in a telephone set and located near an ear of a talking user of the telephone set.

28. Method according to claim 21, characterized in that the talker speech signal and the returned signal are taken off from an established telephone link.

29. Method according to claim 28, characterized in that the produced output signal of the objective measurement is fed to a control input of an echo-minimizing device included in the established telephone link.

30. Method according to claim 29, characterized in that the output signal of the objective measurement is fed to a monitoring system (F, G).

31. Method according to claim 21, characterized in that the talker speech signal, and either the combined signal or the returned signal are signals laid down in a data base.

32. Device for measuring a talking quality of a telephone link in a telecommunications network, the device comprising measurement means for an objective measuring of a perceptual quality of speech signals, the measuring means being provided with:

a first input port for receiving a first speech signal (s(t); s) transmitted or to be transmitted via a forward channel of the telephone link;

a second input port for receiving a second speech signal (s'(t); s'), which is a function of the first speech signal affected in the telecommunications network;

an output port for an output signal representing an estimated value of the perceptual quality of the second speech signal with respect to the first speech signal, characterised in that the device additionally comprises signal combination means for combining the first speech signal (s(t); s) and a third speech signal (r(t); e), thereby generating the second speech signal (s'(t); s'), the first and third speech signal being respectively a talker speech signal and a signal which occurred in a return channel of the telephone link as a consequence of the transmission of the talker speech signal in a forward channel of the telephone link, and the output signal representing an estimated value concerning the talking quality.

33. Device according to claim 32, characterized in that the signal combination means comprise a signal adder.

34. Device according to claim 32, characterized in that the signal combination means are provided with first and second signal inputs, which are coupled to the forward channel and the return channel of an established telephone link, respectively, and that the first input port of the measurement means is coupled to the forward channel, and the second input port of the measurement means is coupled to the signal output of the signal-combination means.

35. Device according to claim 34, characterized in that the output port is coupled to a control input of an echo-minimizing device included in the established telephone link.

36. Device according to claim 32, characterized in that the first and the second input ports are coupled to a data base of speech signals, on which the first speech signal, and either the second speech signal or the echo signal, are laid down.

37. Telephone-link circuit for a telephone link in a telecommunications network, comprising a forward channel and a return channel, and an echo-minimizing device included between the forward channel and the return channel, characterised in that the telephone-link circuit further comprises:

a signal combiner provided with first and second signal inputs, which are coupled to the forward channel and the return channel of a telephone link, respectively, and with a signal output; and

an objective measurement device provided with a first input port coupled to the forward channel and a second input port coupled to the output of the signal combiner, and an output port, for processing a first speech signal received on the first input port, and with a second speech signal received on the second input port, and for producing an output signal on the output port, said output signal representing an estimated value concerning the talking quality.

38. Telephone-link circuit according to claim 37, characterized in that the output port of the measurement

device has a signal coupling with a control input of the echo-minimizing device.

39. Telephone-link circuit according to claim 37, characterized in that there is further provided for a detection device for detecting the speech status over the established telephone link, and for a switch included in the signal coupling with the control input, the switch being controlled by the detection device.

40. Telephone-link circuit according to claim 37, characterized in that the output port of the measurement device has a signal coupling (F, G) with a monitoring system. --.

REMARKS

The foregoing amendment is made to conform the claims in the application to that amended in the International Preliminary Examination Report, to delete multiple dependent claims and correct minor typographical errors and remove numerical references.

Respectfully submitted,

25 February 2002

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Name of person making certification

(PTT133PREAMEND/81:ca)

21. Method for measuring a talking quality of a telephone link in a telecommunications network, characterized by the following steps:

combining, by means of combining means, a talker speech signal (s(t)) and a signal (r(t)), which occurred in a return channel of the telephone link as a consequence of the transmission of the talker speech signal in a forward channel of the telephone link, to a combined speech signal (s'(t)); and

subjecting the combined speech signal with respect to the talker speech signal to an objective measurement technique for measuring a perceptual quality of speech signals; and

producing an output signal (q(t)) which represents an estimated value concerning the talking quality.

22. Method according to claim 21, characterized in that the combining step comprises a signal addition of the returned signal and the talker speech signal in the electrical domain.

23. Method according to claim 22, characterized in that the signal addition is preceded by an inverse filtering of either the returned signal, or the talker speech signal.

24. Method according to claim 22, characterized in that the returned signal (e4) is taken off from a two-wire part of the telephone link.

25. Method according to claim 22, characterized in that the returned signal (e2, e3) is taken off from a four-wire part of the telephone link.

26. Method according to claim 21, characterized in the combining step comprises a signal combination of the returned signal and the talker speech signal in the acoustical domain.

27. Method according to claim 26, characterized in that the talker speech signal (s) and the returned signal (e5) are combined by means of a microphone, which is additional to the microphone in a telephone set and located near an ear of a talking user of the telephone set.

28. Method according to claim 21, characterized in that the talker speech signal and the returned signal are taken off from an established telephone link.

29. Method according to claim 28, characterized in that the produced output signal of the objective measurement is fed to a control input of an echo-minimizing device included in the established telephone link.

30. Method according to claim 29, characterized in that the output signal of the objective measurement is fed to a monitoring system (F, G).

31. Method according to claim 21, characterized in that the talker speech signal, and either the combined signal or the returned signal are signals laid down in a data base.

32. Device for measuring a talking quality of a telephone link in a telecommunications network, the device comprising measurement means for an objective measuring of a perceptual quality of speech signals, the measuring means being provided with:

a first input port for receiving a first speech signal (s(t); s) transmitted or to be transmitted via a forward channel of the telephone link;

a second input port for receiving a second speech signal (s'(t); s'), which is a function of the first speech signal affected in the telecommunications network;

an output port for an output signal representing an estimated value of the perceptual quality of the second speech signal with respect to the first speech signal, characterised in that the device additionally comprises signal combination means for combining the first speech signal (s(t); s) and a third speech signal (r(t); e), thereby generating the second speech signal (s'(t); s'), the first and third speech signal being respectively a talker speech signal and a signal which occurred in a return channel of the telephone link as a consequence of the transmission of the talker speech signal in a forward channel of the telephone link, and the output signal representing an estimated value concerning the talking quality.

33. Device according to claim 32, characterized in that the signal combination means comprise a signal adder.

34. Device according to claim 32, characterized in that the signal combination means are provided with first and second signal inputs, which are coupled to the forward channel and the return channel of an established telephone link, respectively, and that the first input port of the measurement means is coupled to the forward channel, and the second input port of the measurement means is coupled to the signal output of the signal-combination means.

35. Device according to claim 34, characterized in that the output port is coupled to a control input of an echo-minimizing device included in the established telephone link.

36. Device according to claim 32, characterized in that the first and the second input ports are coupled to a data base of speech signals, on which the first speech signal, and either the second speech signal or the echo signal, are laid down.

37. Telephone-link circuit for a telephone link in a telecommunications network, comprising a forward channel and a return channel, and an echo-minimizing device included between the forward channel and the return channel, characterised in that the telephone-link circuit further comprises:

a signal combiner provided with first and second signal inputs, which are coupled to the forward channel and the return channel of a telephone link, respectively, and with a signal output; and

an objective measurement device provided with a first input port coupled to the forward channel and a second input port coupled to the output of the signal combiner, and an output port, for processing a first speech signal received on the first input port, and with a second speech signal received on the second input port, and for producing an output signal on the output port, said output signal representing an estimated value concerning the talking quality.

38. Telephone-link circuit according to claim 37, characterized in that the output port of the measurement device has a signal coupling with a control input of the echo-minimizing device.

39. Telephone-link circuit according to claim 37, characterized in that there is further provided for a detection device for detecting the speech status over the established telephone link, and for a switch included in the signal coupling with the control input, the switch being controlled by the detection device.

40. Telephone-link circuit according to claim 37, characterized in that the output port of the measurement device has a signal coupling (F, G) with a monitoring system.

(PTT133CLAIMS/81:ca)

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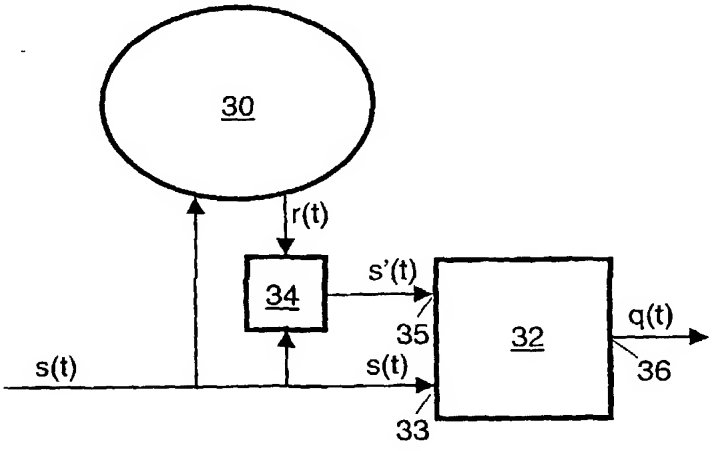
(54) Title: MEASURING THE PERCEPTUAL QUALITY OF SPEECH SIGNALS INCLUDING ECHO DISTURBANCES



(57) Abstract: For measuring the influence of echo on the perceptual quality on the talker's side of a telephone link in a telecommunications network, a talker speech signal (s(t)) and a combined signal (s'(t)) are fed to an objective measurement device (32), such as a PSQM system, for obtaining an output signal (q(t)) representing an estimated value of the perceptual quality. The combined signal is obtained in a signal combiner (34) by signal combination of a returned signal (r(t)) originating from the network and corresponding to the speech signal, and the speech signal (s(t)). The measuring method is applicable to speech signals laid down in a data base, but also to signals directly obtained from a telephone-link circuit, the output signal being fed to a quality-control system and/or to an echo-minimising device.

WO 01/20804 A1

Measuring the perceptual quality of speech signals including echo disturbances.

A. BACKGROUND OF THE INVENTION

1. Field of the invention

The invention lies in the area of measuring the quality of telephone links in telecommunications systems. More in particular, it concerns measuring the influence of echo disturbances and sidetone distortions on the perceptual quality of a telephone link in a telecommunications system as subjectively observed by a talker during a telephone call.

2. Prior art

Echo is a significant factor in the perceptual quality of an end-to-end telephone link during a telephone call. The influence of said factor on the perception may be quantified by measuring the combination of a pair of parameters known by the indications "talker echo loudness rating" and "round-trip delay", such as defined, e.g., in the Recommendation G.107 of ITU-T (Reference [1]; for more bibliographical details relating to the references, see below under D.). For a non-intrusive measurement for determining such parameters, ITU-T Recommendation P.561 (see Reference [2]) provides recommendations. Said known technique, however, has the following drawbacks. To measure the influence of the echo disturbance, first of all a correlation technique is required to determine the delay of the echo. Furthermore, a specific algorithm is required for estimating the "talker echo loudness rating". Moreover, determining the echo delay is difficult when the echo signals are of a low level, i.e., when they are located near the limit of perceptibility, as often is the case with speech on high-quality telephone links. Even if a correct estimate is made of the delay and the loudness, even then the differences in perception of the echo disturbance between different talkers are not capable of being measured, since during the measurement no details of the speech signal can be taken into account. Furthermore effects caused by a distortion of the sidetone signal cannot be taken into account either. Therefore, the known technique shows up only a moderate correlation between the objective measurement results and the more subjective findings of the talkers, particularly in the event of slight echo disturbances and/or sidetone distortions.

In fact, in the event of echo on a telephone link between an A subscriber and a B subscriber, a distinction must be made between a so-called talker echo (from A to A) which the talker at the transmission side (A) may experience during conversation, and a listener echo, which the listener at the receiving side (B) may experience while listening. The perception of the influence on the listener of the listener echo, which in fact consists of twice-reflected speech signals, may basically be quantified using a so-called objective measurement technique, such as the Perceptual Speech Quality Measure (PSQM). With said known technique (see, e.g., references [3] and [4]), which models the perceptual properties of human hearing, the listening quality of a one-way speech signal over a telephone link may be predicted. Quantifying the influence of echo and/or sidetone distortion on the perception of the talker using said technique, i.e. measuring the talking quality, however, is not known and not possible just like that, but it is desirable.

A third factor in the quality of telephony systems is the so-called interaction quality, largely determined by the delays in such systems. The interaction quality together with the listening quality and the talking quality determines an overall quality, called conversational quality, of a telephony service.

References [6], [7] and [8] disclose telephone-link circuits which include echo-minimising devices, such as echo cancelors and echo suppressors, for various kinds of echo, such as acoustic echo caused by acoustic reflections in a teleconferencing room of a teleconferencing system (reference [6]), a so-called electrical echo caused in a four-to-two wire conversion in a PSTN/subscriber interface (reference [7] and [8]), and an acoustical/mechanical type of echo caused in the acoustical and mechanical coupling of the loudspeaker and the microphone in a telephone (hand)set (reference [8]). Such echo-minimising devices are usually applied as near as possible to the origin of the echo signal in question in the telecommunication network. A perceptual quality measurement of any talking quality as indicated above is not disclosed at all.

B. SUMMARY OF THE INVENTION

The object of the invention is to provide for a method and a device for measuring the talking quality, i.e. the influence of returned signals such as echo and/or sidetone distortion on the perceptual quality on the part of the talker of a telephone link in a

telecommunications network, which both does not possess said drawbacks of the known technique and accommodates said desire.

A further object of the invention is to provide for a telephone-link circuit in which the method and the device are applied.

A method for measuring the talking quality of a telephone link in a telecommunications network according to the preamble of claim 1, according to the invention is characterised as in claim 1.

A device for measuring the talking quality of a telephone link in a telecommunications network according to the preamble of claim 12, for the definition of which reference [4] was applied, according to the invention is characterised as in claim 12.

The invention is based on the insight that a talking telephone user simultaneously listens and therefore hears his own speech signal simultaneously with an echo of his speech and any other signals possibly returning from the headphone of the telephone set. Therefore, the application of an original speech signal, i.c. a talker speech signal, and a combined signal, composed of the original talker speech signal and a corresponding returned signal, as input signals for an objective perceptual quality measurement technique of speech signals, such as PSQM, may lead to a usable estimate of the talking quality, whereas such is not the case if only the original talker speech signal and the corresponding echo or any other corresponding returned signal are used. In this way any distortions in either the echo or the sidetone can also be taken into account in the prediction of the talking quality.

A telephone-link circuit for a telephone link in a telecommunications network, comprising a forward channel and a return channel, and an echo-minimising device included between the forward channel and the return channel, for the definition of which reference [8] was applied,according to the invention is characterised as in claim 17.

Further preferred embodiments of the method, the device and the telephone-link circuit of the invention are summarised in the various subclaims.

C. REFERENCES

[1] ITU-T Recommendation G.107: The E-model, a computational model for use in transmission planning, December 1998;

[2] ITU-T Recommendation P.561: In-service, non-intrusive measurement device - voice service measurements, February 1996;

[3] J.B. Beerends and J.A. Stemerdink, A perceptual speech quality measure based on a psychoacoustic sound representation. J. Audio Eng. Soc. 42:115-123, March 1994;

[4] ITU-T Recommendation P.861: Objective quality measurement of telephone band (300-3400 Hz) speech codecs, August 1996;

[5] WO 94/00922;

[6] EP-A-0719028;

[7] WO 97/15124;

[8] WO 99/13596.

All references are considered to be incorporated into the present application.

D. BRIEF DESCRIPTION OF THE DRAWING

The invention will be further explained by means of the description of exemplary embodiments, reference being made to a drawing comprising the following figures:

FIG. 1 schematically shows a known method for measuring the perceptual quality of a speech signal;

FIG. 2 schematically shows a telephone link in a telecommunications network;

FIG. 3 schematically shows a method according to the invention;

FIG. 4 shows part of a telephone-link circuit in which the invention is applied.

E. DESCRIPTION OF EXEMPLARY EMBODIMENTS

FIG. 1 shows a known schematical setup of an application of an objective measurement technique, such as, e.g., the one based on a model of the human hearing and which is usually designated by PSQM, for estimating the perceptual quality of speech over telephone links. It comprises a system or telecommunications network under test 10, hereinafter referred to as network 10 for briefness' sake, and a system 12 for the perceptual analysis of speech signals offered, hereinafter designated, for briefness' sake only, by PSQM system 12. A speech signal d(t) is used, on the one hand, as an input signal of the network 10 and, on the other hand, as a first input signal of the PSQM system 12. An output signal d'(t) of the network 10, which in fact is the speech signal d(t) affected by the network 10, is used as a second input signal of the PSQM system 12. An output signal p(t) of the PSQM system 12 represents an estimate of the perceptual quality of the speech link through the network 10. Since the input

end and the output end of a speech link, particularly in the event it runs through a telecommunications network, are remote, for the input signals of the PSQM system use is made in most cases of speech signals stored on data bases. Here, as is customary, speech signal is understood to mean each sound basically perceptible to the human hearing, such as speech and tones. The system or network being tested may of course also be a simulation system, which simulates a telecommunications network. With this known technique, reliable estimates of the perceptual quality are possible.

FIG. 2 schematically shows a telephone link established between an A subscriber and a B subscriber of a telecommunications network 20. Telephone sets 21 and 22 of the A subscriber and the B subscriber, respectively, are connected by way of two-wire connections 23 and 24 and four-wire interfaces, namely, hybrids 25 and 26, to the network 20. Through the network, the established telephone link has a forward channel including a two-wire part, i.c. two-wire connections 23 and 24, and a four-wire part 27, over which speech signals from the A subscriber are conducted, and a return channel including a two-wire part, i.c. two-wire connections 24 and 23, and a four-wire part 28, over which speech signals from the B subscriber are conducted. An acoustical speech signal s striking the microphone M of the telephone set 21 of the A subscriber, is passed on, by way of the forward channel (23, 27, 24) of the telephone link, to the earphone R of telephone set 22, and becomes audible there for the B subscriber as an acoustical speech signal s" affected by the network. Each speech signal s(t) on the forward channel generally causes a returned signal r(t) which, particularly due to the presence of said hybrids, includes an electrical type of echo signal on the return channel (28, 23) of the telephone link, and this is passed on to the earphone R of the telephone set 21, and may therefore disturb the A subscriber there. Furthermore the acoustic and/or mechanical coupling of the earphone or loudspeaker signal to the microphone of the telephone set of the B subscriber may cause an acoustic type of echo signal back to the telephone set of the A subscriber, which contributes to the returned signal. In an end-to-end digital telephone link (such as in a GSM system or in a Voice-over-IP system) such acoustic echo signal is the only type of echo signal that contributes to the return signal.

Summarizing a returned signal r(t) may include, at various stages in the return channel of a telephone link as caused by a speech signal s(t) in the forward channel of the telephone link:

- a signal e1 representing acoustic echo;
- a signal e2 representing an electrical echo possibly in combination with the acoustic echo;
- a signal e3 which represents the signal e2 as affected, i.e. delayed or distorted, by the network 20;
- a signal e4 which represents the signal e3 in combination with a sidetone signal, and
- a signal e5 which is an acoustic equivalent of the signal e4.

To restrict echo effects in returned signals such as represented by the signals e1 and e2 to a minimum, it is generally customary to include, in telephone-link circuits, echo suppressors or echo cancellers, one at each end of a telephone link. Using the signals present in the forward and return channels, an echo suppressor or canceller continuously makes an estimate of the echo signal and subtracts it from the signal in the return channel. Such an estimate, however, cannot always be carried out reliably, which is particularly the case on high-quality speech links, where the echo signals are at the audibility limit. The optimisation routines applied within such echo suppressors or cancellers do not always provide the best result concerning the perception. Should such optimisation routines be based, at least in part, on the method described below with reference to FIG. 3, then an optimum result having a minimally perceptible echo is possible.

FIG. 3 shows a schematic setup according to the invention, for obtaining an estimate of the perceptual talking quality of a telephone link, for a telephone user when talking on his own telephone set. In a similar manner as the setup of FIG. 1, the setup of FIG. 3 comprises a system or telecommunications network under test 30, hereinafter for briefness' sake referred to as network 30, and a system 32 for the perceptual analysis of speech signals offered, hereinafter for briefness' sake only designated as PSQM system 32. Any talker speech signal s(t) is used, on the one hand, as an input signal of the network 30 and, on the other hand, as first input signal of the PSQM system 32. A returned signal r(t) obtained from the network 30, which corresponds to the input talker speech signal s(t), is combined, in a combination circuit 34, with the talker speech signal s(t) to provide a combined speech signal s'(t), which is then used as a second input signal of the PSQM system. If necessary, the signal s(t) is scaled to the correct level before being combined with the returned signal r(t) in the combination circuit. An output signal q(t) of the PSQM system 32 represents an

estimate of the talking quality, i.e. of the perceptual quality of the telephone link through the network 30 as it is experienced by the telephone user during talking on his own telephone set. Here, too, use may again be made of signals stored on data bases. These may be obtained, e.g., from the telephone set (such as signal e4 in the electrical domain or signal e5 in the acoustic domain) of the A subscriber in the event of an established link during speech silence of the B subscriber. The hybrid between the telephone subscriber access point and the four-wire interface with the network does not, or hardly, contribute to the echo component in the returned signal r(t) (of course, it does contribute to the echo component in a returned signal occurring in the return channel of the B subscriber of the telephone link). However, any such signal contribution has a short delay and, as a matter of fact, forms part of the sidetone.

The signals s(t) and r(t) may also be tapped off from a four-wire part 27 of the forward channel and the four-wire part 28 of the return channel near the four-wire interface 25, respectively. This offers the opportunity of a permanent measurement of the perceptual quality in the event of established telephone links. For this purpose, FIG. 4 schematically shows an embodiment.

FIG. 4 shows, in a similar manner as part of FIG. 2, a two-wire connection 41 which, by way of a four-wire interface, in this case hybrid 43, and of four-wire connection parts 44 and 45, is connected to a telecommunications network 40. Through the network an established telephone link may be set up having a forward channel via the two-wire connection 41 and the four-wire connection part 44 and a return channel via the four-wire connection part 45 and the two-wire connection 41. The line circuit belonging to the telephone link includes an echo canceller 46. Also included is a PSQM system 42, of which a first input port 47 is coupled to the four-wire part 44 of the forward channel, and a second input port 48 is coupled to an output port 49.3 of a signal combiner 49 having two input ports 49.1 and 49.2 which are coupled to the four-wire part 44 of the forward channel and the four-wire part 45 of the return channel, respectively. An output port 50 of the PSQM system 42 for quality-control purposes may be coupled directly, or by way of a switch 51 (arrows F and G), to a monitoring system (not shown). In addition the output port 50, as shown, may be coupled, by way of the switch 51, to a control input 52 of the echo canceller 46. The switch 51 is preferably controlled by a control signal given off by a detection circuit 53 (constructed, e.g., as a "double-talk" detection circuit

known per se), which is coupled to the return channel for detecting the speech status on the four-wire part 45 of the return channel, such as, e.g., speech silence on the part of the B subscriber. Thus, the estimated signal becoming available by way of the output port 50 of the PSQM system may be used, on the one hand, for all kinds of quality-control purposes and, on the other hand, may be used directly in echo-minimising equipment.

In the most simple embodiments, the combination circuit 34 and the signal combiner 49 are signal adders. When applying the method and the device in practice, in the signal combiner carrying out the adding function (addition) is preferably preceded by the so-called "inversely filtering" of one of the signal components. The inverse filter applied there generates a linear estimate of the echo path, and to a major degree contributes towards achieving a high correlation between an objective measurement and a subjective observation.

In a further embodiment, the signal combination of the speech signal s(t) and the returned signal r(t) is carried out in the acoustical domain, e.g. by recording the relevant acoustical signals by means of one or more additional microphones, to the one used in the telephone handset, near one or both ears of the talking user. In its simplest form the acoustical signal at the non-telephone ear is used as a first input to the PSQM system while the acoustical signal at the telephone ear is used as the second input signal to the PSQM system. In case a so-called head-and-torso-simulator (HATS) is used, the microphones located in the artificial ears of such a HATS can be used. In case only a single microphone is used the first input signal to the PSQM system can be recorded from the acoustic domain using a reference telephone handset while the second input signal to the PSQM system can be recorded from the acoustic domain using the telephone handset with the network under test. (WEGLATEN In this case both recordings contain the same natural acoustical sidetone that can be used to align the non-simultaneously recorded signals.)

F. CLAIMS

1. Method for measuring a talking quality of a telephone link in a telecommunications network,
characterised by the following steps:
- combining, by means of combining means (34), a talker speech signal (s(t)) and a signal (r(t)), which occurred in a return channel of the telephone link as a consequence of the transmission of the talker speech signal in a forward channel of the telephone link, to a combined speech signal (s'(t)), and
- subjecting the combined speech signal with respect to the talker speech signal to an objective measurement technique (32) for measuring a perceptual quality of speech signals, and
- producing an output signal (q(t)) which represents an estimated value concerning the talking quality.

2. Method according to claim 1, characterised in that the combining step comprises a signal addition of the returned signal and the talker speech signal in the electrical domain.

3. Method according to claim 2, characterised in that the signal addition is preceded by an inverse filtering of either the returned signal, or the talker speech signal.

4. Method according to claim 2 or 3, characterised in that the returned signal (e4) is taken off from a two-wire part (23) of the telephone link.

5. Method according to claim 2 or 3, characterised in that the returned signal (e2, e3) is taken off from a four-wire part (28) of the telephone link.

6. Method according to claim 1, characterised in the combining step comprises a signal combination of the returned signal and the talker speech signal in the acoustical domain.

7. Method according to claim 6, characterised in that the talker speech signal (s) and the returned signal (e5) are combined by means of a microphone, which is additional to the microphone in a telephone set (21) and located near an ear of a talking user of the telephone set.

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8. Method according to any of the claims 1,-,7, characterised in that the talker speech signal and the returned signal are taken off from an established telephone link.

9. Method according to claim 8, characterised in that the produced output signal of the objective measurement (42) is fed to a control input (52) of an echo-minimising device (46) included in the established telephone link.

10. Method according to claim 9, characterised in that the output signal of the objective measurement is fed to a monitoring system (F, G).

11. Method according to any of the claims 1,-,7, characterised in that the talker speech signal, and either the combined signal or the returned signal are signals laid down in a data base.

12. Device for measuring a talking quality of a telephone link in a telecommunications network (30; 40), the device comprising measurement means (32; 42) for an objective measuring of a perceptual quality of speech signals, the measuring means being provided with:

- a first input port (33; 47) for receiving a first speech signal (s(t); s) transmitted or to be transmitted via a forward channel of the telephone link,
- a second input port (35; 48) for receiving a second speech signal (s'(t); s'), which is a function of the first speech signal affected in the telecommunications network,
- an output port (36; 50) for an output signal representing an estimated value of the perceptual quality of the second speech signal with respect to the first speech signal,

characterised in that

the device additionally comprises signal combination means (34; 49) for combining the first speech signal (s(t); s) and a third speech signal (r(t); e), thereby generating the second speech signal (s'(t); s'), the first and third speech signal being respectively a talker speech signal and a signal which occurred in a return channel (24, 28, 23; 45, 41) of the telephone link as a consequence of the transmission of the talker speech signal in a forward channel (23, 27, 24; 41, 44) of the telephone link, and the output signal representing an estimated value concerning the talking quality.

AMENDED SHEET

13. Device according to claim 12, characterised in that the signal combination means comprise a signal adder.

14. Device according to claim 12 or 13, characterised in that the signal combination means (49) are provided with first (49.1) and second (49.2) signal inputs, which are coupled to the forward channel (44) and the return channel (45) of an established telephone link, respectively, and that the first input port (47) of the measurement means (42) is coupled to the forward channel, and the second input port (48) of the measurement means is coupled to the signal output of the signal-combination means (49).

15. Device according to claim 14, characterised in that the output port (50) is coupled to a control input (52) of an echo-minimising device (46) included in the established telephone link.

16. Device according to claim 12 or 13, characterised in that the first and the second input ports are coupled to a data base of speech signals, on which the first speech signal, and either the second speech signal or the echo signal, are laid down.

17. Telephone-link circuit for a telephone link in a telecommunications network, comprising a forward channel (41, 44) and a return channel (45, 41), and an echo-minimising device (46) included between the forward channel and the return channel,
characterised in that
the telephone-link circuit further comprises:

- a signal combiner (49) provided with first and second signal inputs (49.1, 49.2), which are coupled to the forward channel (44) and the return channel (45) of a telephone link, respectively, and with a signal output (49.3), and
- an objective measurement device (42) provided with a first input port (47) coupled to the forward channel (44) and a second input port (48) coupled to the output (49.3) of the signal combiner (49), and an output port (50), for processing a first speech signal received on the first input port, and with a second speech signal received on the second input port, and for producing an output signal on the output port, said output signal representing an estimated value concerning the talking quality.

18. Telephone-link circuit according to claim 17, characterised in that the output port (50) of the measurement device has a signal coupling with a control input (52) of the echo-minimising device (46).

19. Telephone-link circuit according to claim 17 or 18, characterised in that there is further provided for a detection device (53) for detecting the speech status over the established telephone link, and for a switch (51) included in the signal coupling with the control input (52), the switch being controlled by the detection device.

20. Telephone-link circuit according to any of the claims 17, 18 or 19, characterised in that the output port (50) of the measurement device has a signal coupling (F, G) with a monitoring system.

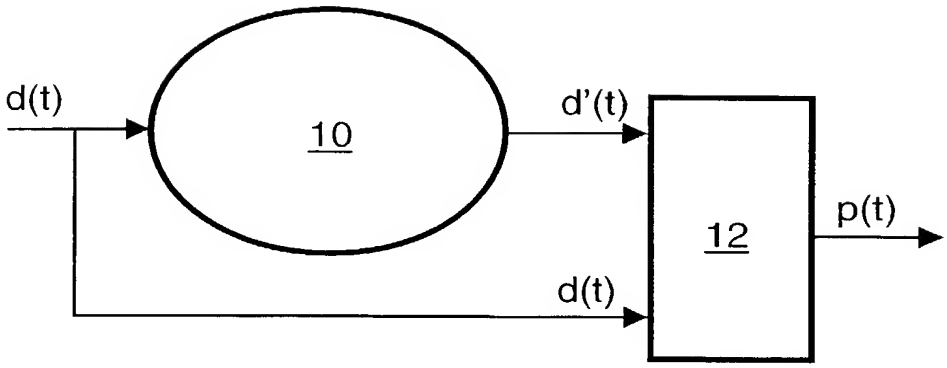
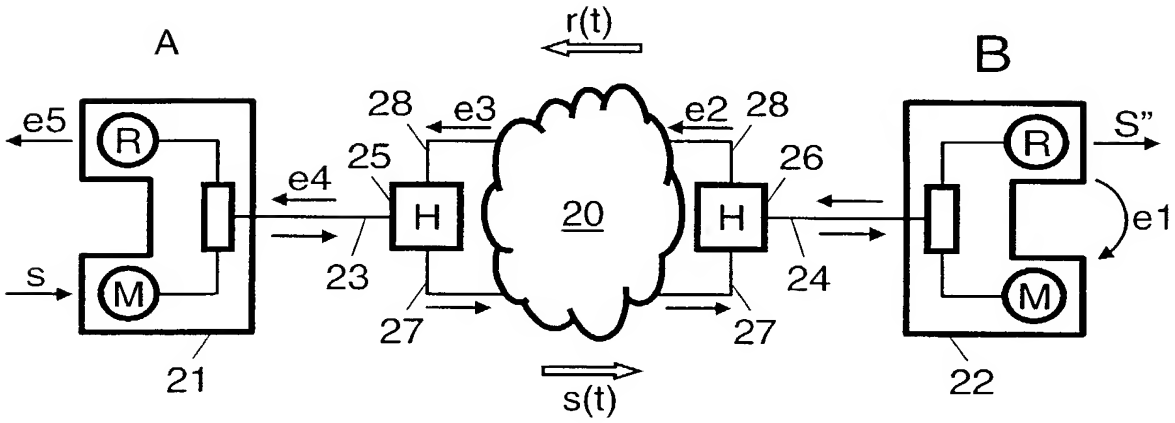

d(t)
10
d'(t)
12
p(t)
d(t)

FIG. 1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r(t)
B
e5
R
28
e3
e2
28
S"
e4
25
H
20
H
26
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24
M
27
27
21
s(t)
22

FIG. 2

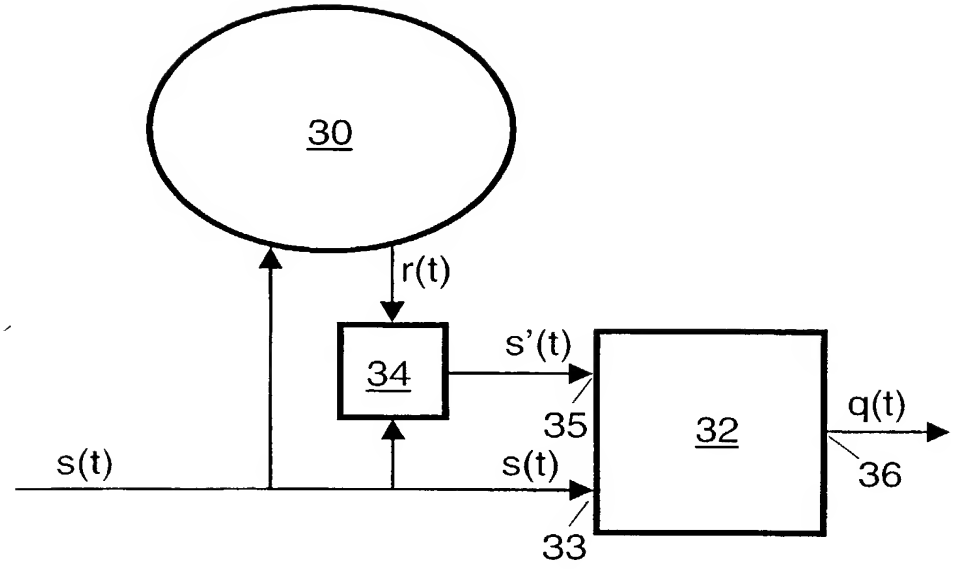
30
r(t)
34
s'(t)
35
32
q(t)
36
s(t)
s(t)
33

FIG. 3

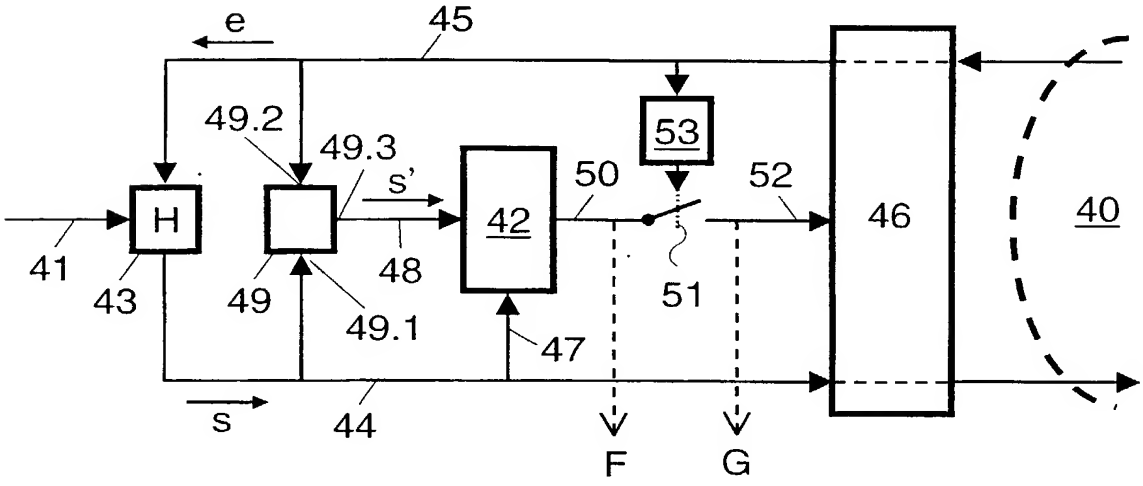
e
45
49.2
49.3
s'
53
50
52
46
40
H
42
41
43
49
48
49.1
51
47
s
44
F
G

FIG. 4

Atty. Doc. No.: _____

DECLARATION AND
POWER OF ATTORNEY
(Utility Patent Application)

As a below named inventor, I hereby declare:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below), of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"Measuring the perceptual quality of speech signals including echo disturbances."

the specification of which:

__ is attached hereto
__ was filed on as Application Serial No.
with amendment(s) filed _____
X was filed as PCT international application: PCT/EP00/08884
and was amended under PCT Article 19 on 25 October 2001

hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations section 1.56.

I hereby claim foreign priority benefits under Section 119 of Title 35, United States Code for the above-identified US patent application based on the patent or inventor's certificate identified below and having a filing date before that of the US patent application for which priority is claimed:

Application No	Country	Filing Date	Priority Claimed under 35 USC 119
1013044	NL	September 15, 1999	YES

I hereby claim the benefit under Section 120 and/or Section 119(e) of Title 35 of the United States Code of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by Section 112 of Title 35 of the United States Code, I acknowledge the duty to disclose material information, as defined in Section 1.56 of Title 37 of the Code of Federal Regulations, which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status: Patented	Pending	Abandoned

Power of attorney:

As a named inventor, I hereby appoint:

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as my attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office in connection therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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country

Signature: _____

Date: February 4, 2002